



# Newsletter

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The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

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## Ozone, Stress, and the Pests of Cottonwood

Stress is being linked to all sorts of human ailments ... but how do plants react to stressful conditions? Does environmental stress such as air pollution affect their resistance to pathogens and pests? And, if so, how? What changes occur to make plants more -- or less -- susceptible to infection or being eaten?

Ecologists have discovered that plants often use chemical defenses against their attackers. However, the same plant may not be well defended at all times. Its resistance may be influenced by its environment, for example the amount of sun, shade, nutrients or water it receives, and by other stressful situations such as insect damage and perhaps air pollution. Two years ago IES Chemical Ecologist Dr. Clive Jones and his colleagues started a project to see if air pollution stress affects the resistance of cottonwood trees to insects and pathogens.

Cottonwood trees are an important wood and fiber species, are fast growing and abundant, and probably have the best-studied physiology of all trees. They are therefore good experimental subjects. Ozone was chosen as the environmental stress because it is an important atmospheric pollutant known to be poisonous to plants. Ozone has a number of effects on plants including disruption of photosynthesis, the process by which plants produce energy, by "knocking holes in the cell membranes and making them leaky".

Two insect pests and one pathogen were

selected for use in the experimental system. Each organism is an economically important pest of cottonwood in its natural environment, and each pest has a different way of making a living at the plants' expense: a beetle that chews leaves, an aphid that sucks sap, and a pathogenic rust fungus that parasitizes living tissue.

Young cottonwood plants were grown in the greenhouse or in field chambers with charcoal-filtered air to prevent ozone exposure. The plants were then stressed for five hours by fumigation with ozone at a concentration that is the same as that found in urban and suburban areas in the northeastern United States. Control plants were exposed to charcoal-filtered air. Forty hours later the plants were tested to see if they were more or less resistant to the pests and pathogens.

Results after two field seasons are intriguing, and show that air pollution can both increase and decrease plant resistance to pests. The results also indicate that effects are influenced by the way the pests exploit the plant. The beetles preferred, and ate more of, ozone-treated cottonwoods but did not actually grow or survive better on these plants. Presumably the food quality was not as good because more had to be eaten to support the same amount of growth. Beetles also produced fewer eggs on these plants, and chose not to lay them on the ozone-treated leaves. These findings show that a number of characteristics of the beetles' food --

*continued on page 2*



*Patricia Cleveland and Clive Jones examine growth of the experimental cottonwood plants.*

EMIL KELLER

## Cloud Water Project Meeting



Shown around the new cloud water collector are, l. to r.: Standing: W.B. Bowden, Yale School of Forestry and Environmental Studies; J. Kadlec, Atmospheric Sciences Research Center - SUNY at Albany; G.E. Likens, IES; F.H. Bormann, Yale School of Forestry and Environmental Studies; B.T. Bormann, U.S. Forest Service, Alaska; F. Gilliam, U. of Virginia; C. High, Dartmouth College; P. Muir, Holcomb Research Inst., Indiana; S. Bicknell, Humboldt State U., California; T. Siccama, Yale School of Forestry and Environmental Studies. Front row: R. Tarrant, Oregon State Univ.; B.C. Daube, Jr., Caltech; W. McDowell, SUNY at Oswego; K.C. Weathers, IES, Meeting Coordinator; K. Kimball, Appalachian Mt. Club, New Hampshire; J.S. Eaton, IES.

Scientists are discovering that chemicals in clouds and fog may have a considerable influence on ecosystems, especially in mountainous or coastal areas which are apt to be bathed in these suspended water droplets for extended periods of time. Where there is acid rain there also may be acid clouds, and the potential for detrimental effects on natural ecosystems warrants further study.

From 1983 to 1986, scientists at the Institute of Ecosystem Studies collaborated with colleagues from across North America on a Cloud Water Project (CWP). Coordinated from IES, the aim of the CWP was to study cloud and rain water

chemistry in coastal and mountain sites across a wide geographical area from Puerto Rico to Alaska. One of the more significant results from the Project was the recording of an acidic cloud/fog water event at six non-urban sites in the eastern United States ranging from Maine to Virginia. During one week in August 1984, the pH of the cloud/fog water was a very acidic 2.8 - 3.09 (the pH of 'normal' rain is 5.6 and 'neutral' is 7.0) and concentrations of sulfate and nitrate were 7 - 43 times greater than those for average precipitation at eastern sites. This event was reported in the February 20th, 1986 issue of the prestigious scientific journal *Nature*<sup>1</sup>.

On March 4th, scientists who are cooperators in the Cloud Water Project met at the Institute to compare and summarize recent findings and plan future research strategies. One subject under discussion was a new cloud water collector, designed by Bruce C. Daube, Jr., which works by actively pulling atmospheric droplets across teflon strands, where the droplets collect and drip into a collector.

1. K.C. Weathers, G.E. Likens, F.H. Bormann, J.S. Eaton, W.B. Bowden, J.L. Anderson, D.A. Cass, J.N. Galloway, W.C. Keene, K.D. Kimball, P. Huth, D. Smiley. 1986. A regional acidic cloud/fog water event in the eastern United States. *Nature*. Vol. 319, pp. 657-658.

## Cottonwood

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cottonwood leaves -- had been changed by the ozone.

The aphids, however, were not affected at all, perhaps because their nourishment, the plant sap, is not changed by ozone. The rust fungus always did worse on ozone-treated plants, perhaps because ozone damaged the plant tissues and this pathogen needs undamaged tissues to live. All the effects of ozone on insect and pathogen resistance occurred at concentrations that are known to have no direct effect on the growth of the plants themselves, so these consequences of air pollution are ones that would not necessarily be detectable directly. Clearly, ambient air pollution by ozone has the potential to alter the balance between cottonwood and its pests.

Why does cottonwood resistance change? What is it about the cottonwood leaves that has changed chemically or physically to make them more or less palatable or nutritious to other organisms? Can these changes be used as indicators of

environmental stresses in nature? How does stress cause these chemical changes? What other types of stress would produce the same effects?

Dr. Jones and his collaborators have recently received National Science Foundation funding for two more years of research on the cottonwood stress problem. Many of the experiments will be repeated, but this time the chemistry of charcoal-filtered air and ozone-treated plants will be compared. Extracts of plants will be added to leaf disks to see if they affect preference by beetles and germination of the rust; in this way it may be possible to isolate the chemicals responsible for changes in resistance due to air pollution stress. Such chemical changes -- 'signals' -- in stressed plants could be used as indicators of environmental stress in native plants.

Air pollution and its effects on plants are environmental concerns with widespread economic and ecologic ramifications. The "what's", "how's" and "why's" of pollution-related stress are questions worth serious study and are being addressed in several of the Institute's

current programs. Working with Dr. Jones on the cottonwood stress research are Dr. William Smith of Yale University who is a co-principal investigator, and James Coleman, a Yale graduate student and Cary Fellow who is doing his doctoral thesis on the project. Assisting with the work this year are Ines Lorusso, a recently hired research assistant, summer students Patricia Cleveland (Cornell University) and Andrea Kirn (University of Montana), and volunteers Sheila Newman and Patrick Cusack.

\* \* \* \* \*

Clive G. Jones is a staff scientist at the Institute of Ecosystem Studies, and began working at the Mary Flagler Cary Arboretum in the summer of 1980. In addition to the ozone work, he is trying to predict outbreaks of the gypsy moth and to determine the role -- if any -- of plant chemistry, is looking at how the chemistry of lichens that live under rock surfaces affects snails that eat those lichens -- and therefore eat rock! -- and is seeing how the diet of grasshoppers affects the chemicals they use to defend themselves against predators.

## New Staff

**NINA CARACO**, Geochemist. In February, Dr. Nina Caraco joined the IES staff as a postdoctoral associate. Dr. Caraco received her doctorate in biogeochemistry from Boston University. Her thesis research, done at the Marine Biological Laboratory in Woods Hole, Massachusetts, dealt with phosphorus cycling in Sider's Pond, a coastal pond in Falmouth, and her IES research will be of a similar nature. She will be spending approximately one-half her time at the laboratories of the Hubbard Brook Ecosystem Study in West Thornton, New Hampshire collecting and evaluating data for a project investigating the nutrient sources for Mirror Lake. This project, funded by the National Science Foundation, was described in detail in the January-February IES Newsletter.

**MARTHA DOWNS**, Research Asst. I. Martha Downs graduated in December 1985 from Cornell University with a bachelor's degree in natural resources. She is working for Manager of Laboratory Facilities John Eaton, analyzing water samples from the Hubbard Brook Ecosystem Study.



Jean Hubbell, Judy Lane, Martha Downs

**JEAN HUBBELL**, Research Assistant I. Jean Hubbell, with a bachelor's degree in botany from the University of Vermont, worked at the Institute of Arctic and Alpine Research in Boulder, Colorado before coming to work at IES this spring. She is assisting Plant Ecologist Gary Lovett with his dry deposition research (as described in the March-April issue of the Newsletter), operating the air quality station at the research field, and helping to design chambers for fumigation of branches of white pine and sugar maple with air pollutants.

**JUDY LANE**, Research Assistant II. As assistant to Aquatic Microbiologist Jonathan Cole, Judy Lane is developing synthetic growth media for marine and freshwater blue-green algae, and also is developing a protocol for measuring both amounts of chlorophyll and nitrogen fixation rates for these algae. She has a master's degree in ecology from the University of California at Davis.

**ANNETTE FRANK**, Librarian. Annette Frank came to the Institute in May from the Cabrini Medical Center in New York City where she had been an assistant librarian. She obtained her degree in library science from the Eotvos Lorand University of Sciences in Budapest, Hungary. Her priorities at the Institute include streamlining the procedure for interlibrary loans, bringing the reference collection up to date and putting the reprint collection on line. The Institute has acquired a micro-computer for the library, so Ms. Frank will be using this tool in much of her work.



## Promotions



Allan Kling, a member of the staff since July 1976, has been promoted to foreman of gardeners. His promotion from the position of gardener, effective at the beginning of June, gives him a supervisory role in the management of grounds and display gardens.

## IES Events



**NATIONAL SCIENCE WEEK '86**, from May 11-17, was observed at IES with special public activities each afternoon. National Science Week is a nationwide event that was launched in 1985 by the National Science Foundation as a means of encouraging students to become more involved with science and mathematics. For the IES program, students and other interested individuals throughout Dutchess County were invited to visit the Wildlife Lab, to observe research in progress at the Greenhouse, to learn about acid cloud water research, to tour the Plant Science Building, and to become acquainted with the Institute's weather station. Above: At the latter site, located within the IES Research Field, Manager of Laboratory Facilities John Eaton, kneeling, described the meteorological data collected here, and the research projects which make use of this information.

\* \* \* \* \*

**ECOLOGICAL EXCURSION:** During the last weekend in May, forty-two people from as far away as Erie, Pennsylvania and Rutland, Vermont joined Dr. Mark McDonnell and Jill Cadwallader for the IES ecological excursion "Cape Cod Ecology and Whale Watch". Here, Terrestrial Ecologist McDonnell points out some of the plant life -- rugged enough to withstand salt spray and high winds but quickly killed by the wayward human footstep -- of the area adjacent to the Atlantic White Cedar Swamp near Wellfleet, Massachusetts.



## Distinguished Service Award

At its Annual Meeting of the Corporation on May 8th, the Board of Managers of The New York Botanical Garden presented four Distinguished Service Awards. One recipient was Edward A. Ames, trustee of the Mary Flagler Cary Charitable Trust.

Ned Ames has been actively involved with the conservation movement in the United States for two decades. Since 1975, when he joined the Trust, this work has included assisting fellow trustees and The New York Botanical Garden first with the creation of an education and research program at the Mary Flagler Cary Arboretum, and more recently with the development of the Institute of Ecosystem Studies on Arboretum grounds. The Distinguished Service Award was presented to Mr. Ames in recognition of his many and varied contributions to the program of The New York Botanical Garden.

## Grant To Cary Fellow

Yale graduate student Lars O. Hedin is a Cary Fellow at the Institute, working with his Ph.D. thesis supervisor, Dr. Gene E. Likens, on the role of organic carbon in natural stream ecosystems. He has recently been awarded a grant from Sigma Xi, The Scientific Research Society, to study "Microbial Activity in Stream Sediments: Impact on Major Nutrient Cycles". Mr. Hedin, who has been at the Institute since last fall, is a native of Sweden.

## Summer Calendar

### COURSES

Fall Adult Education Program courses will begin in mid-September. Catalogues will be sent to all members and previous course participants in early August. If you are not already on our mailing list and would like to receive a catalogue, call the Gifford House at the number below.

### ECOLOGICAL EXCURSIONS

Fall excursions include:

Island and Marine Ecology in Bermuda  
Hudson River Ecology Cruise on the Sloop Clearwater  
Forest and Lake Ecology at Mohonk Mountain  
Catskill Mountain Ecosystems  
Estuarine Ecology: Canoe Exploration of Constitution Marsh

For details and registration information, call the number below as soon as possible. Deadlines for most of these excursions are fast approaching ....

### SUNDAY PROGRAMS

Public programs are offered on the first and third Sundays of each month. All programs run from 2:00 - 4:00 pm and start at the Gifford House unless otherwise noted. They are open to everyone at no cost.

Tentative schedule (please call the number below to confirm the day's topic):

August 3rd, A stream in summer  
(D. Strayer)  
August 17th, Woodlot management for small landowners (J. Kays)  
September 7th, A stream walk  
(S. Findlay)  
September 21st, Air quality and the forest  
(G. Lovett)

*For more information, call (914) 677-5359 weekdays from 8:30-4:30*

### ART EXHIBITIONS

From time to time artists exhibit their works in the lobby of the Plant Science Building. These exhibits are open to the public on weekdays from 8:30 - 4:30. Admission is free.

Now through August 15th, "Plants in City Windows" by Max Spoerri  
August 24th - October 10th "Fescues & Lagers" by Ray Donarski

### ARBORETUM HOURS

Monday through Saturday, 9 a.m. to 4 p.m.; Sunday, 1 - 4 p.m. The Gift and Plant Shops are open Tuesday through Saturday 11 a.m. to 4 p.m.; Sunday 1 - 4 p.m. Closed on public holidays. All visitors must obtain a free permit at the Gifford House for access to the Arboretum. Roads closed to vehicles when snow covered.

### MEMBERSHIP

Take out a membership in the Mary Flagler Cary Arboretum. Benefits include a special member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, six issues of the IES Newsletter each year, free subscription to *Garden* (the beautifully illustrated magazine for the enterprising and inquisitive gardener), and parking privileges and free admission to the Enid A. Haupt Conservatory at the New York Botanical Garden in the Bronx. Individual membership is \$25; family membership is \$35. For information on memberships, contact Janice Claiborne at (914) 677-5343.

**Note:** Your membership contribution to the Mary Flagler Cary Arboretum is eligible for the IBM Matching Grants Program for Hospitals and the Arts.

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